

**Extend**

File Edit Library Model Text Develop Run Window Help

100% X:758 Y:475

**LIFE Optimization Demo.mox**

ENVIRONMENTAL CONDITIONS

111

SOIL TYPES

112

LAND USE

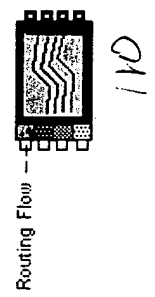
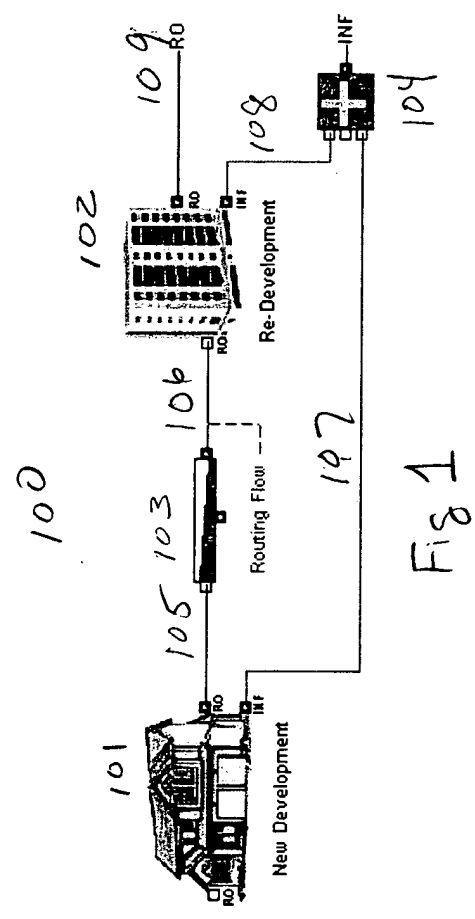
113

Evolutionary Optimizer

114

WATERSHED PROTECTION CRITERIA

115



**CH2MHILL LIFE DYNAMIC SIMULATION**

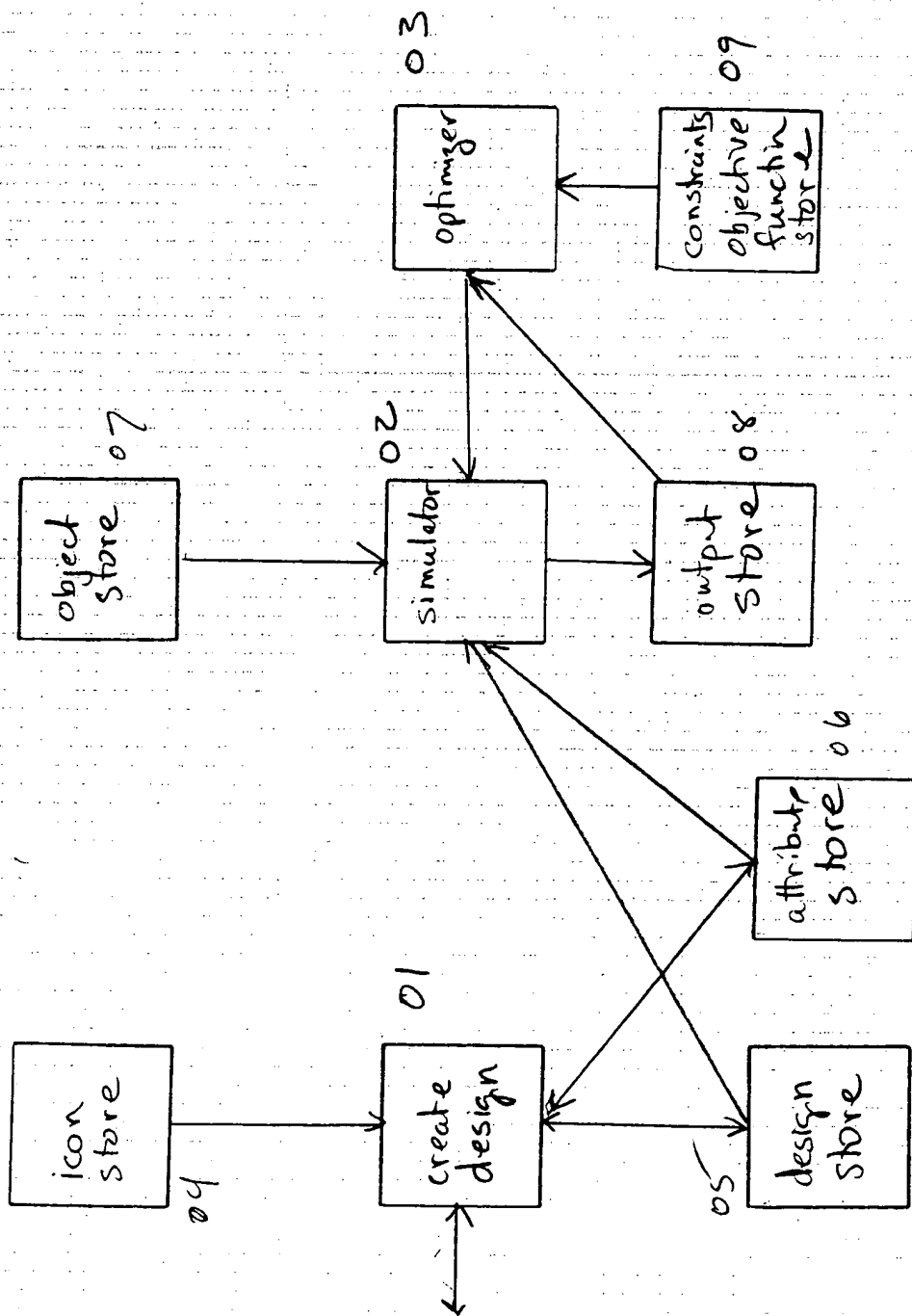


Fig 2



# ENVIRONMENTAL CONDITIONS

300

Environmental Conditions

File Path & Name: C:\Temp\Rainfall.xls

Start Row: 6 Col: 4 Connection: 0

Time Series Data: mm Total Rainfall: 2581

Day	Rainfall (mm)
0	0.00
1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00
9	0.00

Get Data

Comments

Help

303

302

301

301

Fig 3

Environmental Conditions

Elevation: 560 ft Julian Day: 1

Latitude: 41 Temperature: 60 F

Costal: Humid Max: 105 Min: 30

Time Series Data: mm Calculate

Day	Rainfall (mm)
0	0.7
1	0.09
2	0.08
3	0.09
4	0.1
5	0.11
6	0.12
7	0.13
8	0.11
9	0.13

Comments

Help

Costal →

312

313

311



400

## SOIL TYPES

[2] Soil Types

Soil Type Definition

Hydraulic Capacity (HC) in:

OK Cancel

Type	HC-Surf	HC-Sub	Max WC	Fld Capacity	Wilting Pt	Half-life(hr)	ET Mult	Soil Depth	Max Ponding
0 Pervious Lot	1	0.5	0.0	0.5	0.3	12	0.8	12	0
1 Unused Pervious	1	.5	0.0	0.5	0.2	12	0.9	10	0
2 Bio Retention	1	.5	0.0	0.5	0.2	12	1	12	32
3									
4									
5									
6									
7									
8									
9									

Comments

Help

401

Fig 4



500

## LAND USE

[288] Areas

Area Summary

OK

Cancel

	Pervious	Impervious	Total
0	3508805	854000	4362805

Output File: c:\Temp\Life Outputs.xls

Worksheet: Areas

Start Cell: R: 4 C: 1

Export Data: 0

Comments

Help

501

Fig 5



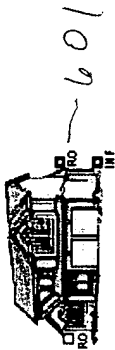
ENVIRONMENTAL  
CONDITIONS



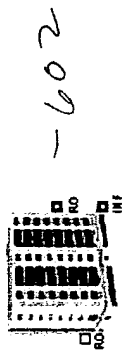
SOIL TYPES

GIS  
IMPORT

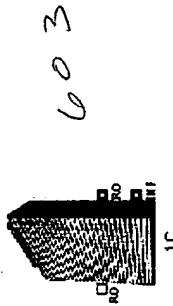
Add blocks



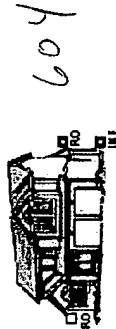
1A



1B



1C



1D



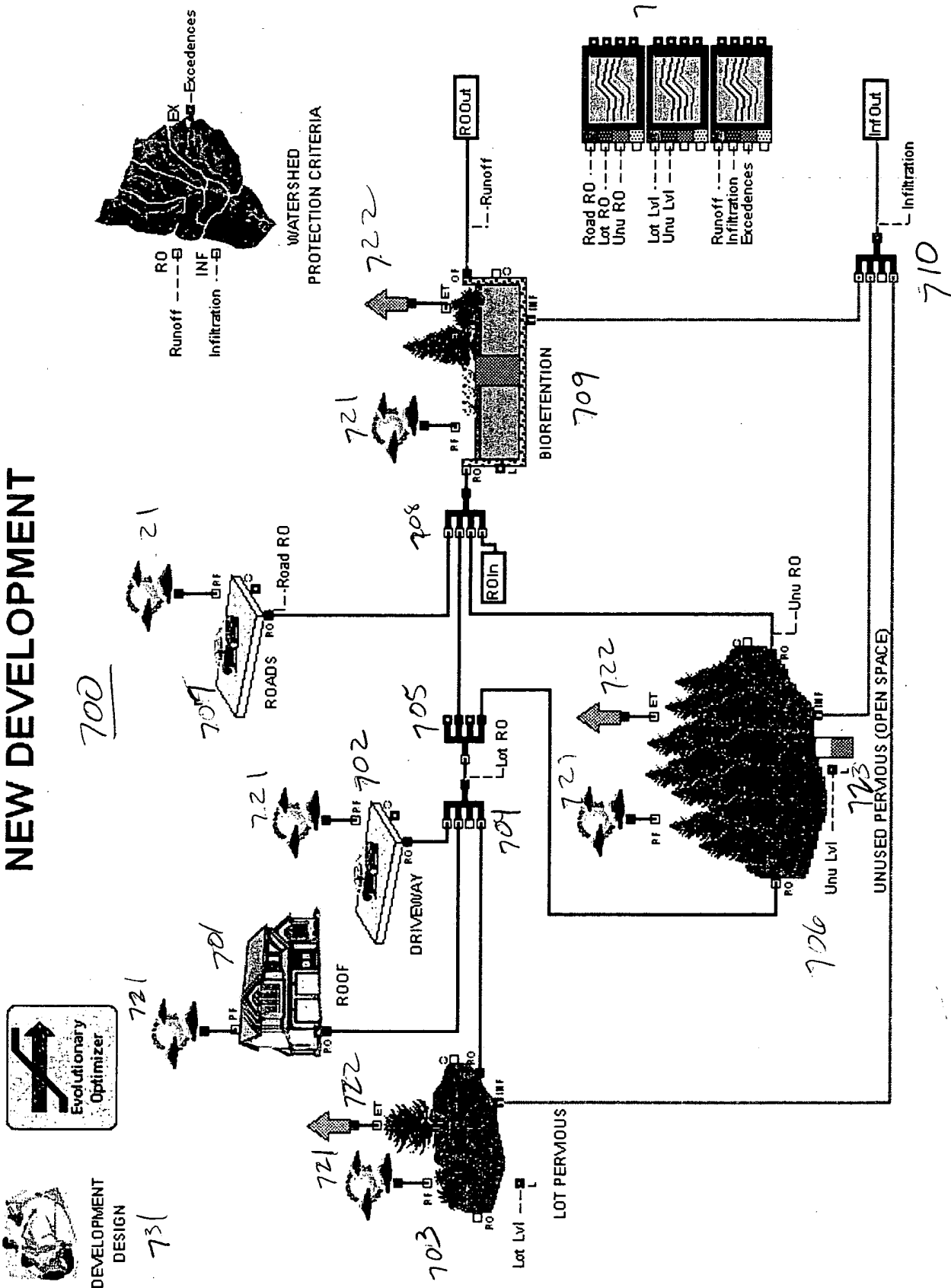
1E

Fig 6

CH2MHILL LIFE DYNAMIC SIMULATION

504

## NEW DEVELOPMENT





800

## DEVELOPMENT DESIGN

**[98][120] Development Design**

Development Design

Area:  No of Lots:  Max:  Calc:

Total Available:  Value per Lot \$:  Profit \$:

Maximum Impervious:  Construction & Permitting Cost: %  \$

Total Impervious:  Source Control & Open Space Costs: \$

Net Profit: \$

**Typical Lot Composition**

	Block No	Type	Surface	Fixed Area	Area/Lot	Start level
0	47	Road	Impervious	10000	1000	
1	31	Rooftop	Impervious	0	1500	
2	27	Driveway	Impervious	0	500	
3	20	Onlot Pervious	Pervious	0	5500	5
4						
5						
6						
7						
8						
9						

Exceedences:

Limit:

**Source Controls**

	Blk No	Type	Area	Ponding Depth	Start Level	Cost/Depth/Are	Cost/Area	Cost \$
0	41	Bio Retention	4583	12	5	5	10	320810
1								
2								
3								
4								

**Open Space**

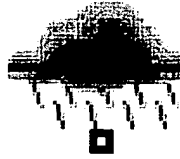
	Blk No	Area	Start Level	Cost/Area	Cost \$
0	51	954000	5	5	4824000
1					
2					
3					
4					

**Comments**

801

Fig 8





900

**[136][106] Rainfall**

Rainfall  
=====

Current Rainfall Rate

Comments

901

Fig 9



- 1000

[140][109] Evapotran

Evapotranspiration

Current Rate 0.1 mm

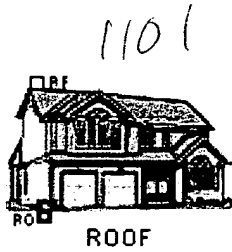
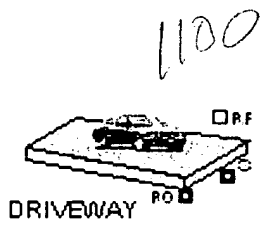
OK Cancel

Comments

Help

100'

Fig 16



[31][9] Roof

Impervious Surface ☐ SI Units

Area: 208500 ft<sup>2</sup>

Runoff Coefficient: 0.9

Rainfall: 1.4 in

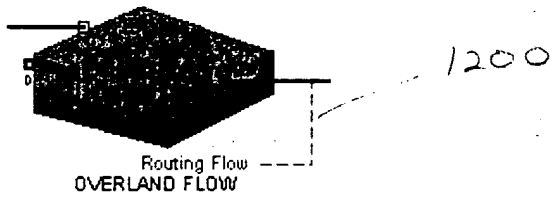
	Current	Total
Volume	21892	21388970
Average Runoff Rate	6.0812	

Comments

Help Low Density

1102

Fig 11



**[15] Routing**

Overland flow parameters: Volume, Depth, Flow

Flow Routing: OK Cancel

Total area contributing: 100000

Width of flow path: 1000

Average slope of flow: 0.001

Manning's roughness: 0.014

Depression storage: 0

Convergence: 0.001

Comments:

1201

**[15] Routing**

Overland flow parameters: Volume, Depth, Flow

Flow Routing: OK Cancel

Inflow: 5.0185634

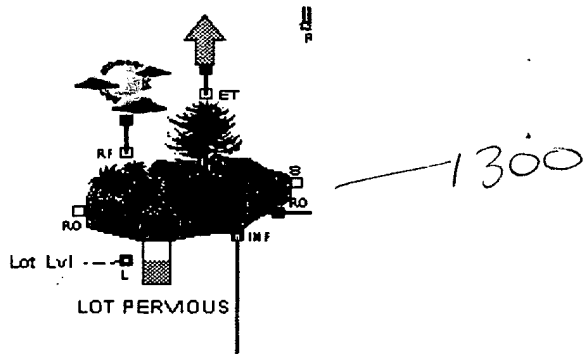
Flow depth: 0.0354139

Outflow: 4.0350862 113/s

Comments:

1202

Fig. 12



**[29][7] Soil Infiltration**

Characteristics | Water Balance | Soil Data | Model Parameters

Infiltration Area: 764500 ft<sup>2</sup> ☐ SI Units

Max Ponding Depth: 0 in

Design Soil Depth: 12

Crop Coefficient: 0.8

Comments

Fig. 13a

Fig 13b

**[29][7] Soil Infiltration**

Characteristics Water Balance Soil Data Model Parameters

Water Level: 6.1968 In ☐ SI Units OK

Flow Balance

	Current Timestep	Total
Inflows	mm ft <sup>3</sup> /s	ft <sup>3</sup>
Runoff In	0	0
Rainfall	1.4	3430718.4
Outflows		
ET	0.1	848695.23
Overflow	0	0
Infiltration	0.2187 0.15234	2505778.9

Cancel Calc Level

Comments

1302

Fig 13c

[29][7] Soil Infiltration

Characteristics Water Balance Soil Data Model Parameters

Soil Type: Pervious Lot ☐ SI Units

Saturated Hydraulic Capacity: in/hr

Surface: 1

Sub-Surface: 0.5

Max Water Content: 0.9

Field Capacity: 0.5

Wilting Point: 0.3

Soil Water Half-life: 12 Hours

OK Cancel Calc Level

Comments

1303

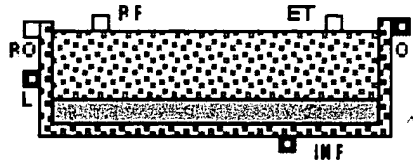


Fig 14a

1400

**[339] Media Infiltration**

Model Parameters

Characteristics Water Balance Media Data

Infiltration Area  ft<sup>2</sup> ☐ SI Units

Max Ponding Depth  in

Storage Depth

ET Multiplier

Void Space Ratio

OK Cancel Calc Level

Comments

Help Default View

1401



Fig 14b

**[339] Media Infiltration**

Model Parameters

Characteristics Water Balance Media Data

Water Level:  in ☐ SI Units

Flow Balance

Current Timestep Total

Inflows in ft3/s ft3

Runoff In

Rainfall

Outflows

ET

Overflow

Infiltration

Comments

Help  Default View

1402

Fig 14c

**[339] Media Infiltration**

Model Parameters

Characteristics Water Balance Media Data

Storage Medium: Gravel

Saturated Hydraulic Capacity: in/hr

SI Units: ☐

Surface:

Sub-Surface:

OK

Cancel

Calc Level

Comments

Help Default View

1403

Fig 14d

[339] Media Infiltration

Characteristics | Water Balance | Media Data |  
Model Parameters

Effective Depth ☐ SI Units

Maximum  in

Comments

Help  Default View

1404

Soil Type:Pervious

1500

[339] Soil Selection

Soil Type Selection

Soil Type Pervious Lot

☐ Update H-Block Label

Comments

Help

OK

Cancel

1501

Fig. 15

# [315] Watershed Protection Criteria

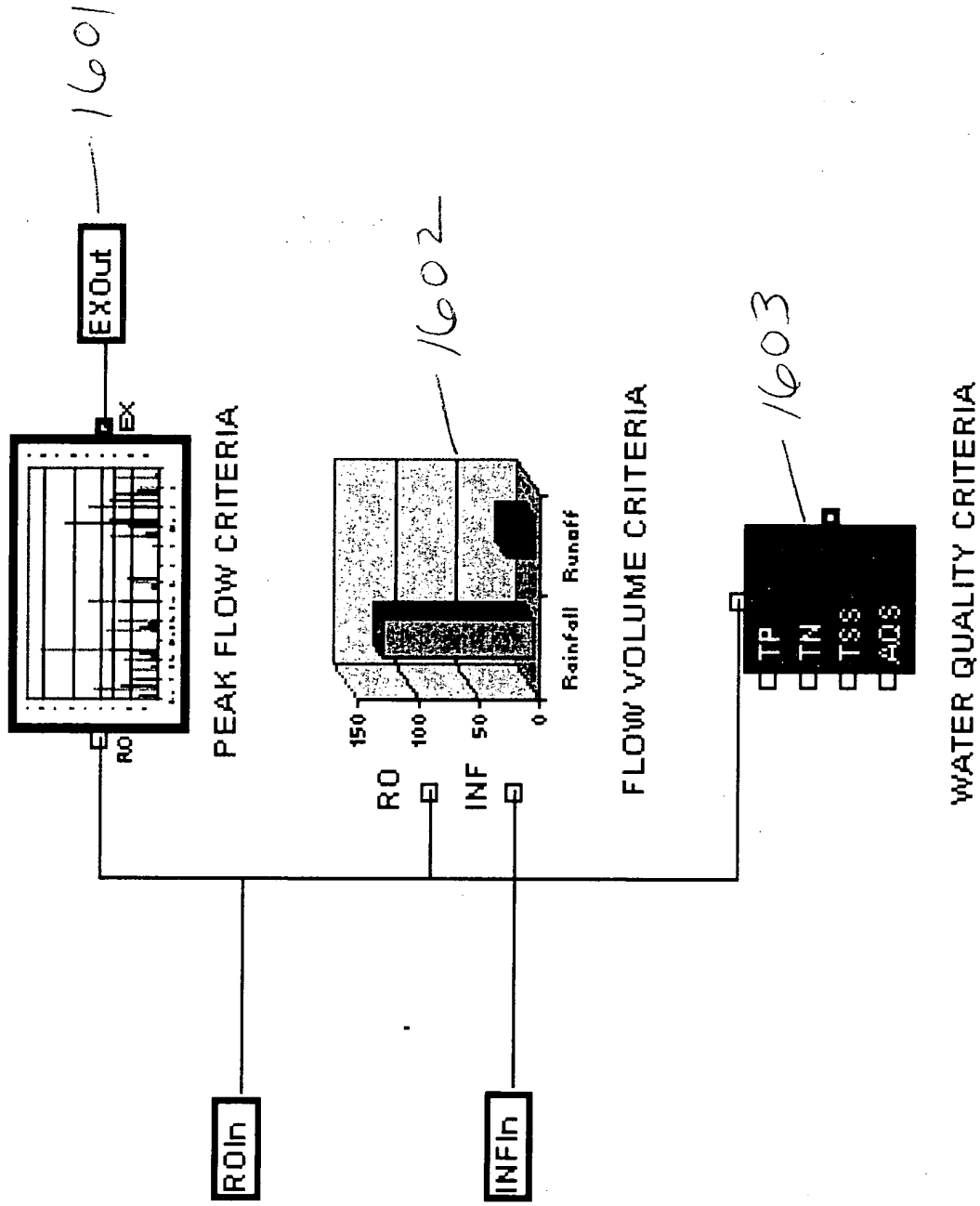
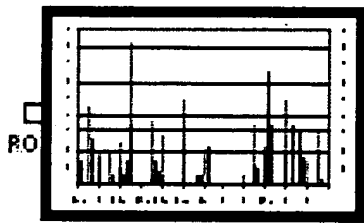


Fig. 16



# PEAK FLOW CRITERIA

**[4][1] Peak Flow Rate**

Average Runoff  
=====

Daily Peak Flow

No of Excedences  Limit

Total Excedence Ratio

Mean Daily Flow

	Day	Runoff
0	1	0
1	2	0
2	3	0
3	4	0
4	5	0
5	6	0
6	7	0
7	8	0.161953724795
8	9	0.195550838597
9	10	0.454606631821

Output File:

Worksheet:

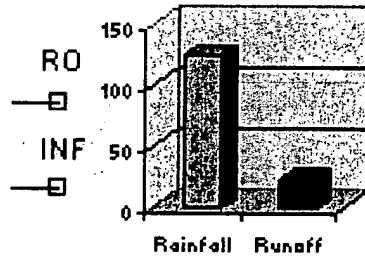
Start Cell R  C

Export Data

Comments

Help

Fig. 17



1800

### FLOW VOLUME CRITERIA

**[265][0] Rainfall vs Runoff**

Water Balance

Target Runoff % of Rainfall:

	Rainfall	Runoff	Infiltration
0	19156400.4803	37566246.9392	19803727.4328

Output File:

Worksheet:

Start Cell: R:  C:

Export Data:

Comments:

Help

1807

F1818

Fig 19a

1901

**[158] Evolutionary Optimizer**

Set Cost | Optimizer Parameters | Constraints | Results | Comments

Optimizes a model: New Run | Continue Run | OK | Cancel

**Variables Table**

Enter limits for variables to be modified. Leave blank for model outputs.  
Limits entered with decimal points are real, without are integer.

Equation Var	Block Number	Block Variable	Row, Col	Mn Limit	Max Limit
0 Ex	333	ex	0,0		
1 NewLots	98	lots	0,0	100	141
2 SCArea	98	source_controls	0,2	0	10000
3 SCDepth	98	source_controls	0,3	0	60
4 NewProfit	98	net_profit	0,0		
5 SCRArea	333	source_controls	0,2	0	20000
6 SCRDepth	333	source_controls	0,3	0	100
7 RDCost	333	net_profit			
8 NewSplit	4	split	0,0	.5	1
9					

Enter an equation in the form: MinCost = equationVar...; or MaxProfit = equationVar...;

MaxProfit = (NewProfit+RDCost)\*(Ex<=40);

Value: 0 | Convergence: % | Total Cases: 10  
Mean: 0 | Sample: 0 | Total Samples: 10  
Help: | Default View

1902

1903



1911

Fig 19b

**[158] Evolutionary Optimizer**

SatCost Optimizer Parameters Constraints Results Comments

New Run Continue Run OK Cancel

Quicker Defaults, Random model Quicker Defaults, Non-Random Model

Better Defaults, Random Model Better Defaults, Non-Random Model

Maximum Samples per Case 5 Show Plot Now

Maximum Cases 1000 ☐ Show Plotter

Member Population Size 10 Clear Plotter

Termination Conditions - convergence checked after 50 cases

☐ Terminate only after maximum cases

☒ Terminate if best and worst within 0.95 (enter 0.999 for 99.9%)

Advanced Cost Statistics (for random only)

☒ Always use Mean of Samples (Default)

☐ Always use Median of Samples

☐ Try both, using best for convergence

☐ Use Artificial Sampling

☐ Truncate tails for mean by 0.2 (i.e. 0.2 is 20%)

Value 0 Convergence % Total Cases

Mean 0 Sample 0 Total Samples 10

Help Default View

Fig 190

1921

1922

Evolutionary Optimizer

Set CostOptimizer ParametersConstraintsResultsComments

Population Best at row 0

AbortAbort

OKCancel

	SCRDepth	RDCost	New Split	Max Profit	samples	error
0	22		0.622107254184	30395917	4	0
1	11		0.678860421988	25109072	3	0
2	11		0.678860421988	25109072	3	0
3	23		0.678860421988	24952302	3	0
4	10		0.678860421988	24950482	3	0
5	10		0.678860421988	24950482	3	0
6	11		0.678860421988	23884112	3	0
7	10		0.678860421988	23312982	3	0
8	34		0.576427762507	22463102	3	0
9	12		0.941609686928		0	0
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

Current convergence metrics: mean

Value30395917Convergence69.3415%Elapsed time00:01:00

Mean30395917Sample0Total Cases10

HelpTotal Samples55

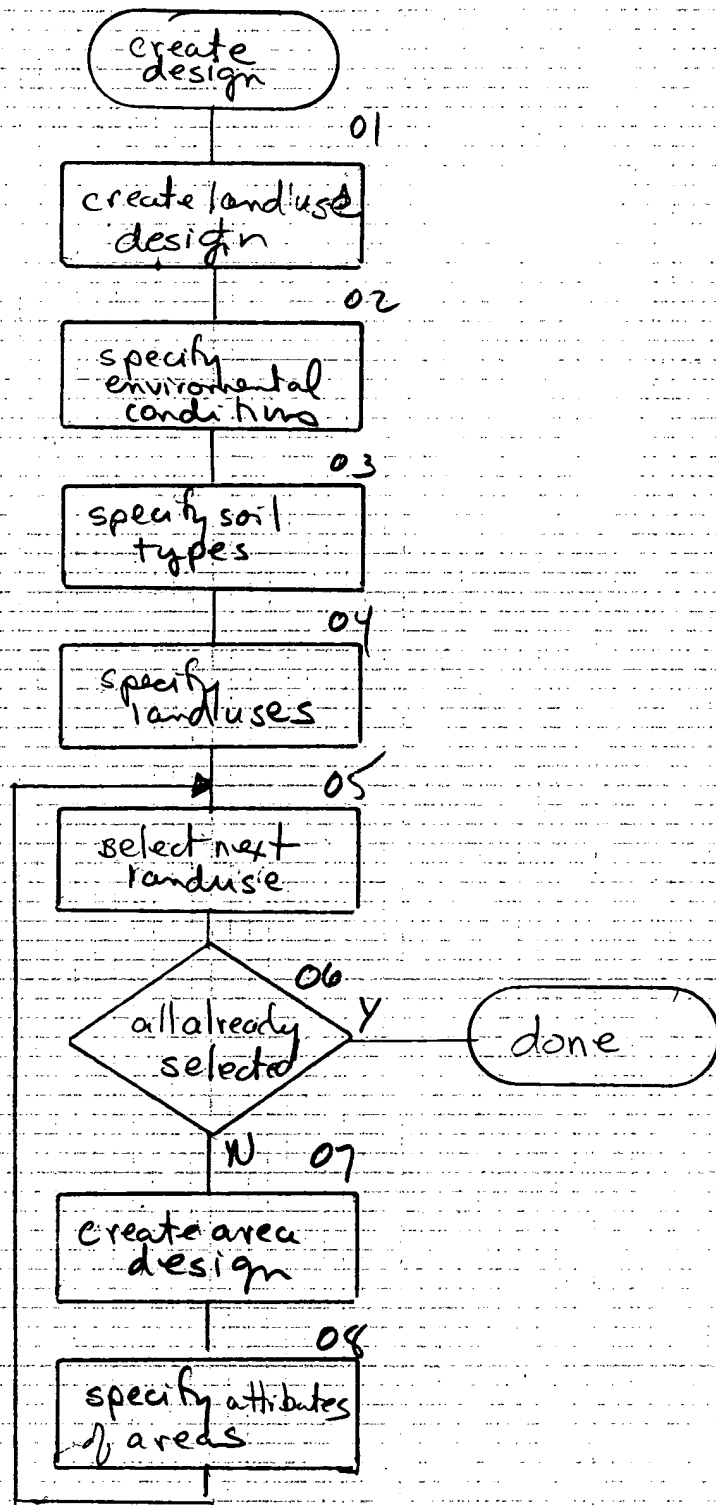


Fig 20

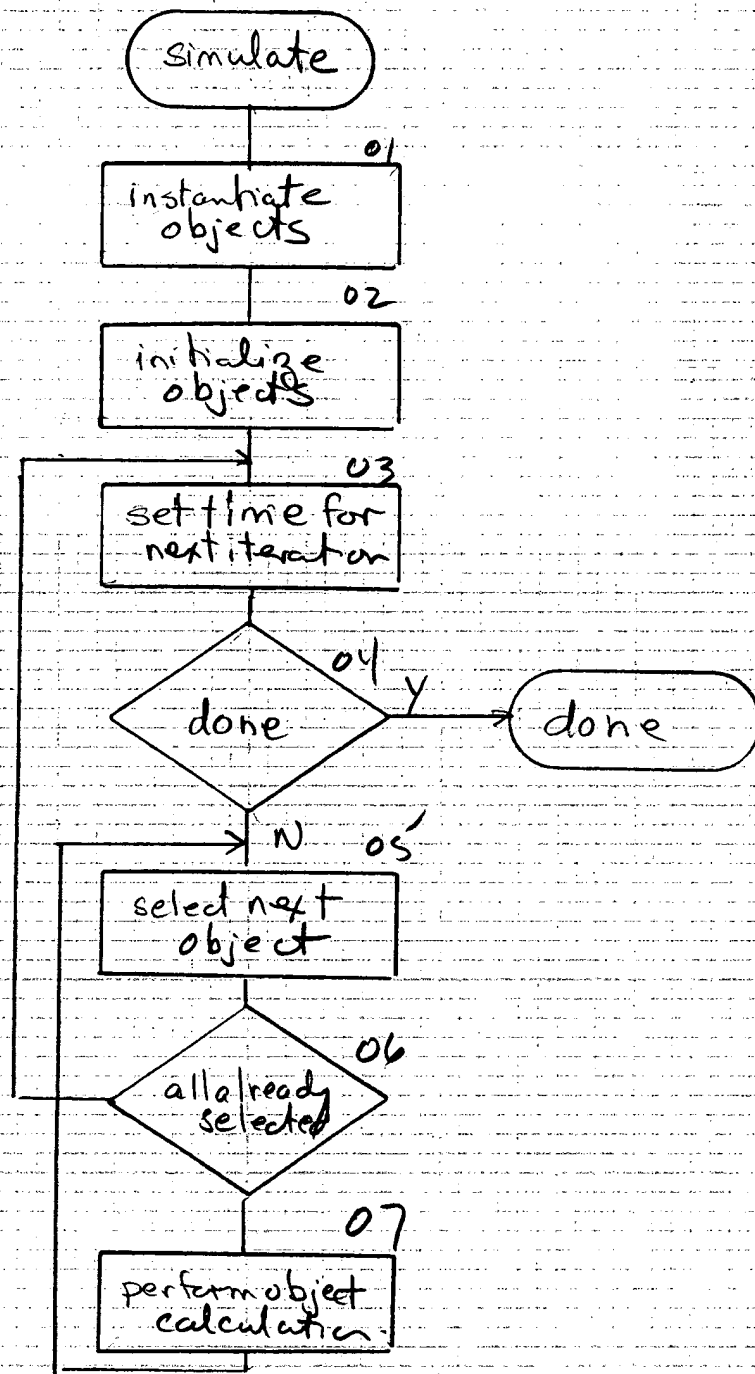


Fig 21

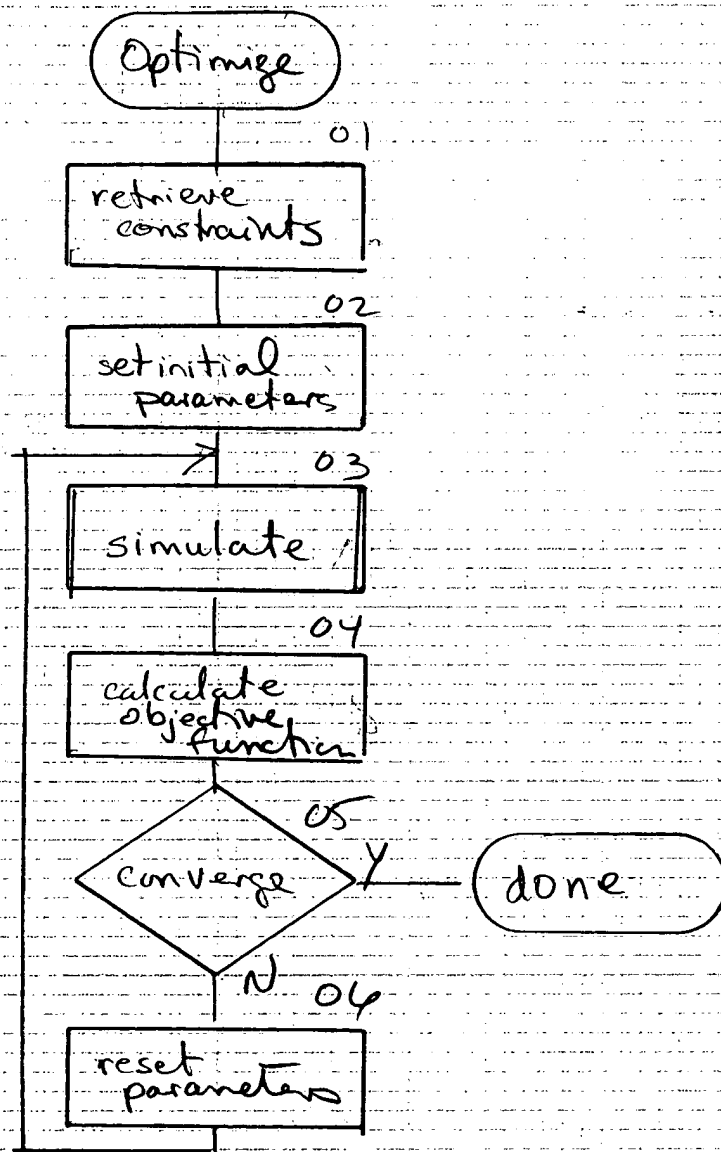


Fig 22

Rainfall  
On Simulate

rainfallout =  
rainfall  
[Current time]

done

Fig 23

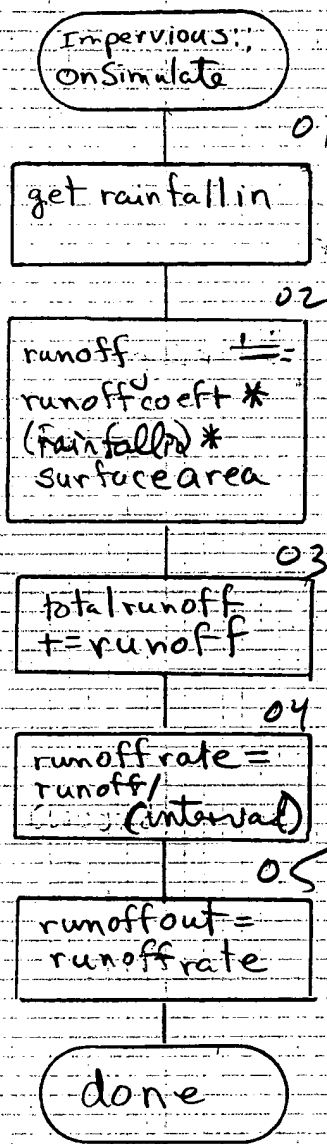


Fig 24

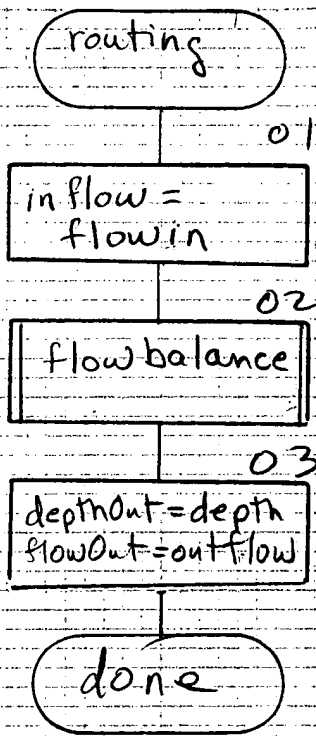


Fig 25



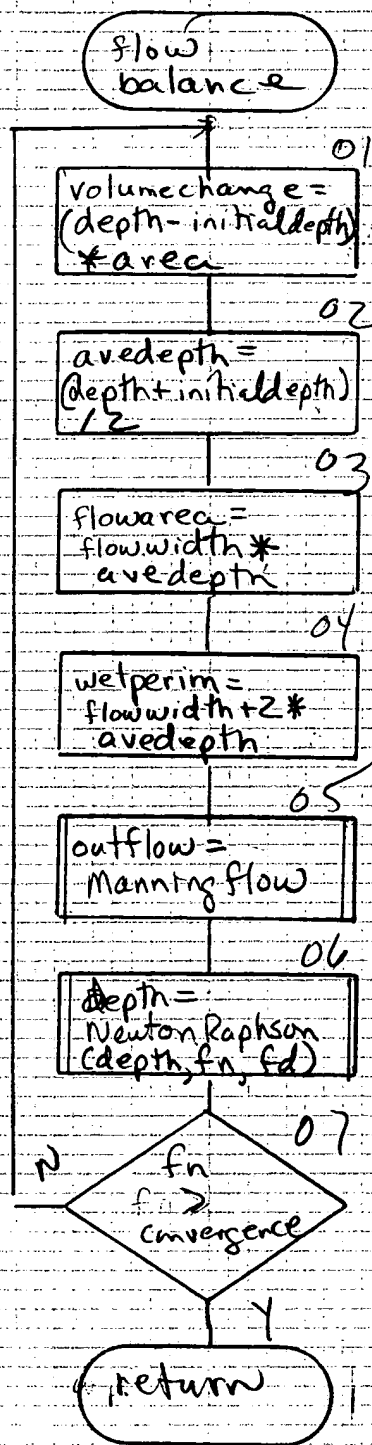


Fig 26

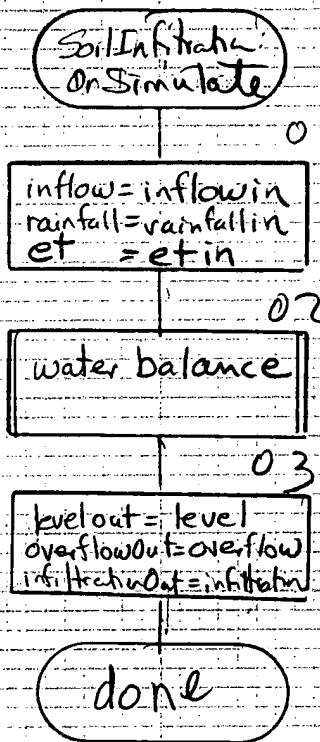


Fig 27

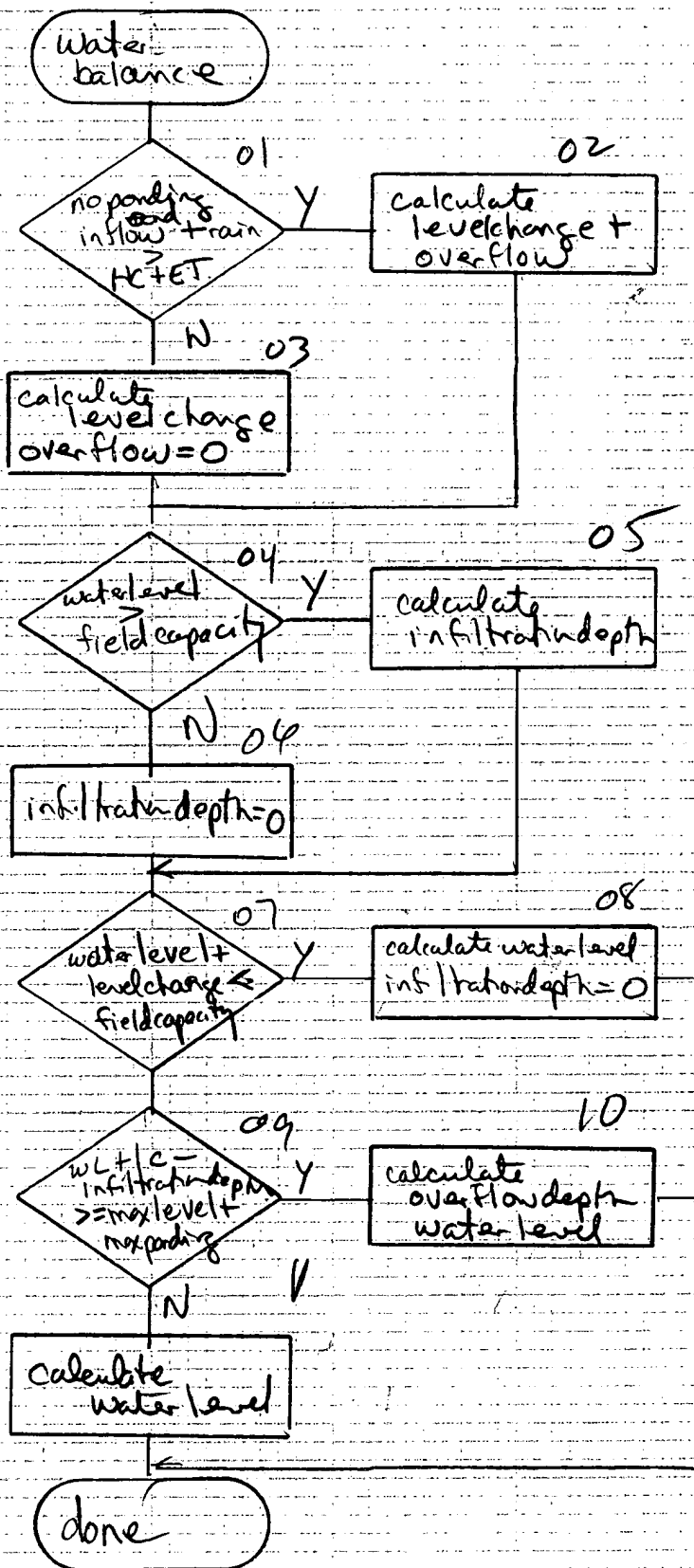


Fig 28